

U.S. PATENT APPLICATION
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FOR
A METHOD AND APPARATUS FOR DISSOLVING UREA

1 METHOD AND APPARATUS FOR DISSOLVING UREA

2
3 CROSS-REFERENCE TO RELATED APPLICATION

4 This application claims the benefit of commonly owned and
5 copending U.S. provisional patent application no. 60/438,024,
6 filed January 3, 2003.

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8 BACKGROUND OF THE INVENTION

9
10 1. Field of the Invention

11 The present invention relates to a method and apparatus for
12 dissolving urea.

13 2. Problem to be Solved

14 U.S. Patent Nos. 4,610,714 and 4,710,360 describe a method
15 and apparatus for dissolving urea without the use of fossil
16 fuel-derived heat. However, the method and apparatus
17 described in these patents are complex and require expensive
18 equipment and machinery. Such equipment and machinery
19 consumes a significant amount of electrical energy.

20 Furthermore, these patents disclose that it is preferred if
21 the method described therein is implemented in warm climate
22 areas. Additionally, the method and apparatus disclosed in
23 the aforementioned patents may need more than one person to
24 operate the apparatus.

25 Another prior art technique is to mix the urea with hot

1 water. However, such a technique consumes significant amounts
2 of electrical energy as well as fossil fuel sources in order
3 to heat the water.

4 Another disadvantage of prior art methods and techniques
5 is the production of ammonia by-products that typically result
6 from the heating of the urea in water to relatively high
7 temperatures (e.g. 130°F, 200°F) in order to accelerate the
8 solution process to prepare commercial truckload quantities
9 (e.g. 45,000 lbs. of 50% urea solution).

10 What is needed is a new and improved method and
11 apparatus for dissolving urea.

12 13 SUMMARY OF THE INVENTION

14 Bearing in mind the problems and deficiencies of the prior
15 art, it is an object of the present invention to provide an
16 improved method and apparatus for dissolving urea that
17 eliminates the problems associated with the prior art
18 techniques discussed in the foregoing description.

19 It is another object of the present invention to provide a
20 new and improved method and apparatus for dissolving urea that
21 does not require directly heating the water or urea.

22 It is a further object of the present invention to
23 provide a new and improved method and apparatus for dissolving
24 urea that does not require expensive or complex equipment and
25 machinery.

1 It is another object of the present invention to provide
2 a new and improved method and apparatus for dissolving urea
3 that utilizes relatively less electrical energy than prior art
4 techniques.

5 It is a further object of the present invention to provide
6 a new and improved method and apparatus for dissolving urea
7 that can be used in warm or cool climates.

8 Other objects and advantages of the present invention will
9 be apparent from the ensuing description.

10 In one aspect, the present invention is directed to a
11 method for dissolving urea. In one embodiment, the method
12 comprises the steps of providing a mixing container,
13 depositing a predetermined amount of urea into the mixing
14 container, and depositing a predetermined amount of water into
15 the mixing container. The predetermined amounts of water and
16 urea form a predetermined urea/water concentration. In one
17 embodiment, the predetermined urea/water concentration is
18 about 50/50 wt/wt. The method further comprises the steps of
19 mixing the urea and water to form a mixture, allowing the
20 mixture to stand for a predetermined amount of time, and
21 thereafter, mixing the mixture until the urea completely
22 dissolves in the water.

23 In a related aspect, the present invention is directed to
24 a method for dissolving urea comprising providing a mixing
25 container, depositing a predetermined amount of urea and a

predetermined amount of water into the mixing container to yield a predetermined urea/water concentration, mixing the urea and the water to form a mixture, monitoring the temperature of the mixture, allowing the mixture to stand until the temperature of the mixture reaches a predetermined temperature, and thereafter, resuming mixing of the mixture until the urea completely dissolves in the water. In one embodiment, the predetermined urea/water concentration is about 50/50 wt/wt. The method further includes maintaining the temperature of the mixture in the mixing container at the predetermined temperature. The predetermined temperature is between about 19°C and 24°C.

In another aspect, the present invention is directed to an apparatus for dissolving urea comprising a mixing container, a urea dispensing device for depositing a predetermined amount of urea into the mixing container, a water dispensing device for depositing a predetermined amount of water into the mixing container, a temperature sensor to measure the temperature of the mixture within the mixing container, a temperature control system for maintaining the temperature of the mixture at a predetermined temperature, and a control system to control (i) the urea and water dispensing devices to deposit predetermined amounts of water and urea into the mixing container to form a predetermined urea/water concentration, (ii) the mixing container to mix the urea and the water to form a mixture,

(iii) the mixing container to cease mixing to allow the mixture to stand for a predetermined amount of time, (iv) the sensor to provide data representing the temperature of the mixture, (v) the temperature control system to maintain the temperature of the mixture at a predetermined temperature, and (vi) the mixing container to resume mixing of the mixture when the temperature of the mixture reaches a predetermined temperature and continue such mixing until the urea completely dissolves in the water to form a solution.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an apparatus, in accordance with one embodiment of the present invention, for carrying out the method of the present invention.

FIG. 2 is a curve of the dissolution time of urea for various amounts of water initially added to the urea.

FIG. 3 is a block diagram of an apparatus, in accordance with another embodiment of the present invention, for carrying out the method of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, there is shown apparatus 10 of the present invention. Apparatus 10 generally comprises mixing container or vat 12 that has a motor-driven mixing blade 13, shown in phantom. In one embodiment, mixing container 12 is

1 enclosed. In another embodiment, mixing container 12 has an
2 open top. Mixing container 12 includes outlet 14 for
3 outputting the product solution. Mixing container 12 can be
4 configured to be of any suitable size depending on the amount
5 of the solution that is required. In one embodiment, outlet
6 14 comprises an electrically controlled output valve. Manual
7 stirring can be used in place of mixing blade 13. Apparatus
8 10 includes urea dispensing device 16 that dispenses a
9 predetermined amount of urea into mixing container 12. In one
10 embodiment, urea dispensing device 16 includes electrical
11 controlled output valve 17 to output the desired amount of
12 urea. Apparatus includes water dispensing device 18. Water
13 dispensing device 18 comprises outlet 19 that dispenses a
14 predetermined amount of water into mixing container 12. In
15 one embodiment, outlet 19 comprises an electrically controlled
16 output valve. In accordance with the present invention, the
17 water in water dispensing apparatus 18 is maintained at room
18 temperature. This feature is described in detail in the
19 ensuing description.

20 Referring to FIG. 1, apparatus 10 further includes
21 temperature sensor 20 for monitoring the temperature of the
22 urea/water mixture in mixing container 12. In one embodiment,
23 all components of apparatus 10 are electronically controlled
24 by an electronic control system. Such an embodiment is shown
25 in FIG. 3 and discussed in detail in the ensuing description.

1 The first step of the method of the present invention is
2 to add a predetermined amount of urea prills to mixing
3 container 12. Thus, urea dispensing device 16 outputs the
4 desired amount of urea prills to mixing container 12. Next,
5 water dispensing device 18 outputs a predetermined amount of
6 water to mixing container 12 so as to achieve a predetermined
7 urea/water concentration. In a preferred embodiment, the
8 predetermined urea/water concentration is 50/50 wt/wt. For
9 example, if 40 grams of urea prills are deposited into mixing
10 container 12, then 40 grams (or ml) of water are added to the
11 urea prills to achieve a 50/50 wt/wt urea/water concentration.
12 The predetermined urea/water concentration may be other than a
13 50/50 wt/wt concentration. The actual predetermined
14 urea/water concentration may depend upon the amounts of urea
15 and water being used as well as the particular application at
16 hand. Furthermore, although the foregoing description is in
17 terms of the urea prills being deposited first to mixing
18 container 12, it is to be understood that the water may be
19 deposited first into mixing container 12 and then followed by
20 the urea prills.

21 The next step of the method of the present invention
22 comprises mixing the urea prills and the water so as to form a
23 mixture. After the mixture is formed, the mixture of urea and
24 water is then allowed to stand for an amount of time
25 sufficient to allow the temperature of the mixture to reach a

predetermined temperature. In a preferred embodiment, the predetermined temperature is between about 19°C and 24°C, and more preferably, about 23°C. The amount of time required for the temperature of the mixture to reach the predetermined temperature depends upon the amount of mixture in mixing container 12. During this time period in which the mixture is allowed to stand, the temperature of the mixture is monitored with temperature sensor 20. When the temperature of the mixture reaches the predetermined temperature, mixing of the urea/water mixture is resumed and continues until the urea completely dissolves in the water. The time for urea dissolution is measured from the moment the mixing resumes to the point in time when the urea becomes completely dissolved in the water. The solution is outputted from mixing container 12 via outlet 14.

It has been found that increasing the volume of water initially added to the urea prills substantially decreases the time for the urea to completely dissolve in the water after a urea/water concentration of 50/50 wt/wt is achieved. A series of tests were conducted in order to determine the urea dissolution time when various amounts of water were initially added to the urea and wherein additional amounts of water were subsequently added to attain the 50/50 wt/wt urea/water concentration. A control test was first conducted in order to obtain reference data. About 40 grams of urea prills were

1 mixed with an equal amount of water, i.e. 40 grams (or
2 milliliters). The mixture was not allowed to stand for any
3 amount of time. Thus, the mixing step began as soon as 40
4 grams of urea and 40 grams of water were added to mixing
5 container 12. The time for the urea to completely dissolve
6 was about twelve (12) minutes and is indicated by numeral 100
7 in the curve of FIG. 2.

8 9 TEST 1

10 In the first test, about 40 grams of urea and 10 grams of
11 water were deposited into mixing container 12. The mixture
12 was then mixed or stirred, and allowed to stand until the
13 temperature of the mixture reached about room temperature or
14 about 23 °C. Next, an amount of water necessary to achieve a
15 urea/water concentration of 50/50 wt/wt was added to the
16 mixture. Since the initial amount of water was 10 grams, 30
17 grams of water were added to the mixture to achieve the
18 desired 50/50 wt/wt concentration. The urea and water were
19 mixed again. The urea completely dissolved in eight (8)
20 minutes after the 50/50 wt/wt urea/water concentration was
21 achieved. This is indicated by numeral 102 on the curve in
22 FIG. 2. The dissolution time was about 33% faster than the
23 control test dissolution time of twelve (12) minutes.

24 TEST 2

25 In the next test, about 40 grams of urea and 15 grams of

1 water were deposited into mixing container 12. The mixture
2 was then mixed or stirred, and allowed to stand until the
3 temperature of the mixture reached about room temperature or
4 about 23 °C. Next, an amount of water necessary to achieve a
5 50/50 wt/wt urea/water concentration was added to the mixture.
6 Since the initial amount of water was 15 grams, 25 grams of
7 water were added to the mixture to achieve the desired 50/50
8 wt/wt urea/water concentration. The urea and water were mixed
9 again. The urea completely dissolved in seven (7) minutes
10 after the 50/50 wt/wt urea/water concentration was achieved.
11 This is indicated by numeral 104 on the curve in FIG. 2. The
12 dissolution time was about 42% faster than the control test
13 dissolution time of twelve (12) minutes.

14 TEST 3

15 In the next test, about 40 grams of urea and 20 grams of
16 water were deposited into mixing container 12. The mixture
17 was then mixed or stirred, and allowed to stand until the
18 temperature of the mixture reached about room temperature or
19 about 23 °C. Next, an amount of water necessary to achieve a
20 urea/water concentration of 50/50 wt/wt was added to the
21 mixture. Since the initial amount of water was 20 grams, 20
22 grams of water were then added to the mixture to achieve the
23 desired 50/50 wt/wt urea/water concentration. The urea and
24 water were mixed again. The urea completely dissolved in five
25 (5) minutes after the 50/50 wt/wt urea/water concentration was

1 attained. This is indicated by numeral 106 on the curve in
2 FIG. 2. The dissolution time was about 58% faster than the
3 control test dissolution time of twelve (12) minutes.

4 5 TEST 4

6 In the next test, about 40 grams of urea and 25 grams of
7 water were deposited into mixing container 12. The mixture
8 was then mixed or stirred, and allowed to stand until the
9 temperature of the mixture reached about room temperature or
10 about 23 °C. Next, an amount of water necessary to achieve a
11 urea/water concentration of 50/50 wt/wt was added to the
12 mixture. Since the initial amount of water was 25 grams, 15
13 grams of water were added to the mixture to achieve the
14 desired 50/50 wt/wt urea/water concentration. The urea and
15 water were mixed again. The urea completely dissolved in four
16 (4) minutes after the 50/50 wt/wt urea/water concentration was
17 attained. This is indicated by numeral 108 on the curve in
18 FIG. 2. The dissolution time was about 67% faster than the
19 control test dissolution time of twelve (12) minutes.

20 TEST 5

21 In the last test, 40 grams of urea and 40 grams of water
22 were added to mixing container 12 so as to produce a 50/50
23 wt/wt concentration of urea and water. The urea prills and
24 water were then mixed or stirred and allowed to stand until
25 the temperature of the mixture reached about room temperature

1 or about 23 °C. As soon as the temperature of the mixture
2 reached about room temperature or about 23 °C, the mixture was
3 mixed or stirred again. The urea completely dissolved in
4 three (3) minutes after a urea/water concentration of 50/50
5 wt/wt was achieved. This is indicated by numeral 110 on the
6 curve in FIG. 2. This dissolution time was about 75% faster
7 than the control test dissolution time of twelve (12) minutes.

8 Although the ensuing description of TESTS 1-5 were in
9 terms of allowing the mixture to stand until the desired
10 temperature of the mixture reached about room temperature or
11 23 °C, it is to be understood that the desired temperature can
12 be any suitable temperature in between about 19°C and 24°C.

13 Thus, by increasing the volume of water initially added to
14 the urea prills, the time for the urea to completely dissolve
15 in the water substantially decreases once a 50/50 wt/wt
16 urea/water concentration is attained.

17 Referring to FIG. 3, there is shown another embodiment of
18 the present invention. Apparatus 200 generally comprises
19 apparatus 10, described previously herein and shown in FIG. 1,
20 and electronic control system 202. In one embodiment,
21 electronic control system 202 comprises a computer having a
22 data input interface, such as a computer keyboard, to allow
23 users to input control data. Electronic control system 202 is
24 in electrical signal communication with output valves 17 and
25 19 of urea dispensing device 16 and water dispensing device

1 18, respectively, so as to control the output flow of these
2 devices. Electronic control system 202 is in electrical
3 signal communication with mixing container 12 to control
4 mixing blades 13. Electronic control system 202 is also in
5 electrical signal communication with outlet 14 to control the
6 flow of solution from mixing container 12. Electronic control
7 system 202 is also in electrical signal communication with
8 sensor 20. Specifically, electronic control system 202
9 receives temperature data from sensor 202 which represents the
10 temperature of the mixture in mixing container 12 and is
11 programmed to control mixing blades 13 to resume mixing when
12 the temperature of the mixture reaches the desired
13 predetermined temperature. Electronic control system 202
14 comprises timing circuitry that also tracks the time in which
15 a mixture of urea and water is allowed to stand before mixing
16 blades 13 are activated and mixing of the mixture resumes.

17 In a preferred embodiment, apparatus 10 is located within
18 a controlled environment so as to prevent significant climatic
19 temperature deviations from having deleterious effects on the
20 dissolution of urea in the water. For example, as shown in
21 FIG. 3, apparatus 10 is located in enclosed room 204.
22 Enclosed room 204 preferably has suitable insulation to
23 facilitate maintaining a constant temperature within room 204.
24 Electronic control system 202 is located outside of enclosed
25 room 204. Enclosed room 204 may be heated or cooled as needed

1 by temperature control system 206. Temperature control system
2 206 may be configured with any commercially available heating
3 or cooling means, e.g. air conditioning, furnace, etc. In one
4 embodiment, a feedback loop is employed wherein electronic
5 control system 202 receives temperature data from sensor 20
6 and then controls temperature control system 206 to maintain
7 the temperature within enclosed room 204 at a desired
8 temperature (e.g. room temperature).

9 It is to be understood that the actual amounts of urea,
10 water, and desired solution can be varied depending upon the
11 application. The foregoing description shall not be construed
12 as limiting the invention to the relatively small amounts of
13 urea, water and solution described in the foregoing
14 description. Thus, the present invention may be used with
15 significantly large amounts of water and urea to produce a
16 significantly large amount of solution.

17 It is to be understood that the predetermined urea/water
18 concentration can be other than 50/50 wt/wt. Specifically,
19 the predetermined amounts of urea and water may be varied so
20 as to achieve a urea/water concentration other than 50/50
21 wt/wt provided that the percent urea does not exceed 50% of
22 the total weight of the predetermined urea/water concentration
23 in order to ensure that the urea completely dissolves in the
24 water at room temperature (i.e. 23 °C). For example, a
25 predetermined amount of urea may be mixed with a predetermined

1 amount of water so as to achieve a urea/water concentration of
2 45/55 wt/wt. In another example, a predetermined amount of
3 urea may be mixed with a predetermined amount of water so as
4 to achieve a urea/water concentration of 35/65 wt/wt. The
5 desired urea/water concentration may be varied depending upon
6 the particular application at hand.

7 Although the foregoing description is in terms of the urea
8 prills being added to mixing container 12 first and the water
9 being added thereafter, it is to be understood that the water
10 may be added first to mixing container 12 and the urea prills
11 added thereafter.

12 The present invention provides many advantages and
13 benefits, namely:

14 a) the water with which the urea prills is mixed does
15 not have to be separately and directly heated, thereby
16 reducing the overall energy consumption in implementing the
17 method of the present invention;

18 b) the rate at which the urea prills dissolve in the
19 water is at least 60% faster than the prior art technique of
20 mixing the urea with hot water without allowing the mixture to
21 stand;

22 c) complex and expensive equipment and machinery are not
23 required; and

24 d) the present invention substantially eliminates the
25 production of ammonia by-products that typically occur in

1 prior art methods and techniques which heat the urea in water
2 to relatively high temperatures (e.g. 130°F, 200°F).

3 The principles, preferred embodiments and modes of
4 operation of the present invention have been described in the
5 foregoing specification. The invention which is intended to
6 be protected herein should not, however, be construed as
7 limited to the particular forms disclosed, as these are to be
8 regarded as illustrative rather than restrictive. Variations
9 in changes may be made by those skilled in the art without
10 departing from the spirit of the invention. Accordingly, the
11 foregoing detailed description should be considered exemplary
12 in nature and not limited to the scope and spirit of the
13 invention as set forth in the attached claims.

14 What is claimed is: